DECLARATION

I, Fumiko YANAGISAWA of c/o KOYO INTERNATIONAL TECHNICAL INSTITUTE, INC., Nikko Kagurazaka Building, 18 Iwato-cho, Shinjuku-ku, Tokyo, Japan, do hereby solemnly declare that the attached pages contain an accurate translation of the official certified copy of Japanese Patent Application No. 2002-349637 and Japanese Patent Application No. 2002-359316 to the best of my knowledge.

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INK JET RECORDING APPARATUS

[PATENT CLAIM]

[Claim 1]

An ink jet recording apparatus comprising:

a recording head of ink jet type for jetting ink from a plurality of jet openings;

a light source for emitting light to cure an ink jetted from the recording head and adhered to a recording medium;

a light quantity measuring section for measuring a light quantity of the light source; and

a light source control section for controlling the light quantity of the light source according to a measurement result by the light quantity measuring section.

[Claim 2]

The ink jet recording apparatus of claim 1, wherein the ink jet recording apparatus comprises a light source scanning section for scanning the light source above the

recording medium by moving the light source in a direction perpendicular to a carrying direction of the recording medium, and a plurality of light sources disposed at different positions seen from the direction perpendicular to the carrying direction of the recording medium, the plurality of light sources being moved in order in a measuring region for the light measuring section to make the light quantity measuring section measure a light quantity of each of the plurality of light sources in order.

[Claim 3]

The ink jet recording apparatus of claim 2, further comprising a recording head scanning section for scanning the recording head above the recording medium by moving the recording head in the direction perpendicular to the carrying direction of the recording medium, wherein the light source scanning section is formed to move the light sources together with the ink jet head by the recording head scanning section.

[Claim 4]

The ink jet recording apparatus of any one of claim 1, claim 2, or claim 3, wherein the ink jet recording apparatus comprises a plurality of light sources and a scanning section, the scanning section moving the light quantity measuring section to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring section.

[Claim 5]

The ink jet recording apparatus of any one of claims 1-4, wherein the ink jet recording apparatus comprises a plurality of light sources at different positions seen from a carrying direction of the recording medium and a scanning section, the scanning section moving the light quantity measuring section in the carrying direction of the recording medium to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring section.

[Claim 6]

The ink jet recording apparatus of any one of claims 1 to 5, further comprising a storage section for storing a desired value of a light controlled by the light source control section, and an informing means for informing a measured result to a user when a measured value measured by the light quantity measuring section is less than the desired value.

[Claim 7]

The ink jet recording apparatus of any one of claims 1 to 6, further comprising a storage section for storing a desired value of a light quantity controlled by the light source control section, wherein a recording operation by the recording head is banned when a measured value measured by the light quantity measuring section is less than the desired value.

[Claim 8]

The ink jet recording apparatus of any one of claims 1 to 7, wherein the ink is cured by an ultraviolet-ray.

[Claim 9]

The ink jet recording apparatus of any one of claims 1 to 8, wherein the ink comprises a cationic polymerization ink.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Industrial Field of the Invention]

The invention relates to an ink jet recording apparatus in which photo-curable ink is used.

[0002]

[Conventional Art]

Generally, in an ink jet recording apparatus, noise during printing is relatively small and the print quality is good, so that it has been widely used.

The ink jet recording apparatus jets fine ink droplets from nozzles of the recording head toward a recording medium such as a paper by using, for example, piezoelectric elements, heater elements or the like, and moves a relative position of the recording head and the recording medium while making ink penetrate the recording medium or fixing ink on the recording medium so as to form an image on the recording medium.

There are, for example, a serial head type and a line head type ink jet recording apparatuses. In the serial head type, a recording head reciprocates on the recording medium and the recording medium is carried in a direction perpendicular to a scanning direction of the recording head for forming an image. In the line head type, a recording head which has a nozzle line having a recording range width for the recording medium is fixed, and an image is formed by carrying the recording medium perpendicular to a width direction of the recording medium.

[0003]

Recently, in a field of printing on goods or packing material for goods, demand for a small-lot production have been increasing, so that the ink jet method in which a small-lot production can be achieved at low cost in comparison with the method such as a gravure printing method or a flexographic method which needs a plate making has been used.

As is well known, material with less ink absorptivity such as resin or metal is quite often used for goods or packing material for goods.

For enabling the ink to be fixed on the recording medium when such the material with less absoptivity is used as a recording medium, an ink jet recording apparatus of photo curable type in which the photo curable ink with high viscosity is irradiated with light such as ultraviolet-rays

(UV-rays) after the ink was jetted and attached to the recording medium to cure and fix the ink on the recording medium has been developed.

[0004]

Earlier, as the ink jet recording apparatus of the photo curable type, an ink jet recording apparatus of an ultraviolet curable type has been put to practical use, in which radical polymerization ink is used and a great deal of UV-rays is radiated all at once. As a light source, it has been proposed to use a light source which radiates light with directivity such as laser beam or the like (see, for example, Patent Document 1). Specifically, as the light source which radiates light with directivity, a semiconductor laser, a light emitting diode or the like is well known.

By using a semiconductor laser or a light emitting diode, a calorific value during irradiation becomes small, so that electric power consumption is lowered. In addition, a light source unit becomes small in comparison with a fluorescent lamp or a high pressure mercury lamp. Moreover, a semiconductor laser or a light emitting diode is good in stability and easy to adjust light quantity.

[0005]

[Patent Document 1]

Japanese Patent Publication Tokukai-hei 2001-310454 (4pages)

[0006]

[Problem to be solved according to the Invention]

However, there has been a following problem in the earlier developed technique.

[0007]

When radical polymerization ink is used, relatively a great deal of UV irradiation is required. Thus, a high-power light source is to be mounted, thereby causing the apparatus to become large and raise the cost of production.

To solve the problem, it is considered to use cationic polymerization ink which has not been put to practical use. However, cationic polymerization ink has a unstable property such as a humidity dependency and a property to cause curing reaction with weak light such as reflection light or the like, so that it is hard to handle and difficult to put into practical use.

For example, degradation of a light source by long-term use lowers lighting intensity to the ink, and decline of lighting intensity is caused by ink mist as the light source gets closer to the recording head by request of miniaturizing the apparatus and the like. Under the circumstances, when the cationic polymerization ink with the above described properties is used, curing failure is likely to occur and it does not reach the stage of practical use.

[0008]

The present invention has been developed in view of the above described earlier developed technique, and in an ink jet recording apparatus in which photo curable ink is used, an object of the present invention is to improve reliability of the apparatus by preventing printing failure by curing failure for enabling ink with high curing sensitivity which is cured by a relatively low-power light source to put into practical use, thereby miniaturizing the apparatus and reducing the cost for production.

[0009]

[Means for Solving the Problem]

In accordance with the present invention, the ink jet recording apparatus of the claim 1 comprises:

a recording head of ink jet type for jetting ink from a plurality of jet openings;

a light source for emitting light to cure an ink jetted from the recording head and adhered to a recording medium;

a light quantity measuring section for measuring a light quantity of the light source; and

a light source control section for controlling the light quantity of the light source according to a measured value by the light quantity measuring section.

[0010]

According to claim 2 of ink jet recording apparatus of the invention, the ink jet recording apparatus comprises:

a light source scanning section for scanning the light source above the recording medium by moving the light source in a direction perpendicular to a carrying direction of the recording medium; and

a plurality of light sources disposed at different positions seen from the direction perpendicular to the carrying direction of the recording medium,

wherein the plurality of light sources are moved in order in a measuring region for the light measuring section to make the light quantity measuring section measure a light quantity of each of the plurality of light sources in order.

[0011]

According to claim 3 of ink jet recording apparatus of the invention, the ink jet recording apparatus comprises:

a recording head scanning section for scanning the recording head above the recording medium by moving the recording head in the direction perpendicular to the carrying direction of the recording medium,

wherein the light source scanning section is formed to move the light sources together with the ink jet head by the recording head scanning section.

[0012]

According to claim 4 of ink jet recording apparatus of the invention, the ink jet recording apparatus of any one of claim 1, claim 2, or claim 3 comprises:

a plurality of light sources and a scanning section,

wherein the scanning section moving the light quantity measuring section to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring section.

[0013]

According to claim 5 of ink jet recording apparatus of the invention, the ink jet recording apparatus of any one of claims 1 to 4 comprises:

a plurality of light sources at different positions seen from a carrying direction of the recording medium; and

a scanning section to move the light quantity measuring section in the carrying direction of the recording medium to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring section.

[0014]

According to claim 6 of ink jet recording apparatus of the invention, the ink jet recording apparatus of any one of claims 1 to 5 comprises:

a storage section for storing a desired value of a light controlled by the light source control section; and

an informing means for informing a measured result to a user when a measured value measured by the light quantity measuring section is less than the desired value.

[0015]

According to claim 7 of ink jet recording apparatus of the invention, the ink jet recording apparatus of any one of claims 1 to 6 comprises:

a storage section for storing a desired value of a light quantity controlled by the light source control section, wherein a recording operation by the recording head is banned when a measured value measured by the light quantity measuring section is less than the desired value.

[0016]

According to claim 8 of ink jet recording apparatus of the invention, the ink jet recording apparatus of any one of claims 1 to 7 comprises:

a storage section for storing a desired value of a light quantity controlled by the light source control section, wherein a recording operation by the recording head is banned when a measured value measured by the light quantity measuring section is less than the desired value.

[0017]

According to claim 9 of ink jet recording apparatus of the invention, the ink of any one of claims 1 to 8 comprises:

a cationic polymerization ink.

[0018]

[Embodiment of the Invention]

Hereinafter, an embodiment of an image forming apparatus of the invention will be explained with reference to figures. The embodiment shows an example of a case the image forming apparatus of the invention is applied to a laser imager. A definition of the invention is not limited to the present embodiment and the figures.

[0019]

[First Embodiment]

The first embodiment of the present invention will be explained referring to FIG. 1. FIG. 1 is a sectional view showing an ink jet recording apparatus of the first embodiment in the present invention.

[0020]

As shown in FIG. 1, the ink jet recording apparatus which is a serial head type comprises ink jet heads 1, a light source device 2, a light quantity measuring sensor 3, a control section 4, a display section 5, and a platen 6.

[0021]

The ink jet heads 1 are an ink jet type recording head in which ink is jetted from a plurality of jet openings, and are well known. The ink jet heads 1 mounted on a carriage (not shown) are reciprocally moved in a main scanning direction A to scan above a recording medium such as a paper or a film which is carried on the platen 6.

In FIG. 1, a carrying direction H of the recording medium (not shown) is a direction perpendicular to a surface of the paper.

A recording head scanning section which moves the recording heads 1 in a direction (main scanning direction A) perpendicular to the carrying direction H of the recording medium to carry out scanning is configured by using the carriage and a well known mechanism for linearly and reciprocally moving the carriage.

[0022]

The light source device 2 is configured to be provided with one or more semiconductor lasers or light emitting diodes as a light source for emitting ultraviolet-rays to cure the ink which is jetted from the ink jet heads 1 and attached to the recording medium, and is well known. The light source device 2 is mounted on the carriage together with the ink jet heads 1, so that it moves with the ink jet heads 1. As the ink, cationic polymerization ink of UV curable type is used. As the recording medium, a resin film with less absorptivity is used.

Accordingly, a light source scanning section is configured, so that the light source device 2 is moved in a direction (main scanning direction A) perpendicular to the carrying direction H of the recording medium to carry out scanning of the light sources above the recording medium. That is, in the embodiment, the light source scanning

section is configured to move the light source device 2 together with the ink jet heads 1 by the recording head scanning section. Therefore, another mechanism for moving the light source device 2 is not required.

[0023]

The light quantity measuring sensor 3 is a light sensor for measuring a light quantity of each light source provided on the light source device 2, and is well known.

The light source control section 4 comprises, for example, a computer and program which is executed in the computer. The light source control section 4 is well known.

The display section 5 comprises an image display device such as a liquid crystal display device for image display, and a voice box for displaying voice is added according to need. In the embodiment, the display section 5 is configured to be able to perform both of the image display and the voice display.

The platen 6 is a member for keeping a carrying position of the recording medium at a predetermined position by supporting the recording medium so as to make the distance between the recording medium and the recording heads, that is, the flight distance of the ink regular, and is well known. When the platen 6 is interposed between the light sources and the light quantity measuring sensor 3, a portion of the platen 6 comprises a transparent member such as transparent glass, resin and the like.

[0024]

A control operation of the light sources according to the embodiment will be explained.

As shown in FIG. 1(b), the light source device 2 is moved to a measuring region C adjacent to a recording region B before or during recording operation by the ink jet heads 1 so as to dispose the light source device 2 at a position in which the light quantity measuring sensor 3 can measure a light quantity of one or more light sources provided on the light source device 2.

Next, the light quantity sensor measuring 3 measures a light quantity of each light source provided on the light source device 2.

The control section 4 controls the light quantity of each light source provided on the light source device 2 according to the measured value of each light source by the light quantity measuring sensor 3. That is, the control section controls the measured value of each light source to be maintained within the range which is not less than the desired value of each light source. The desired values are calculated in consideration of conditions such as a curing property of the cationic polymerization ink and an amount of the dropped ink droplets on the recording medium, or experimentally precalculated to be set at a light quantity required for ink curing. The desired values are stored in the storage section not shown. The control section 4

controls the light quantity by reading out the desired values from the storage section not shown.

For example, the control is performed following the flow chart shown in FIG. 2.

As shown in FIG. 2, when the light quantity measurement starts, the control section 4 reads out the desired value P0 from the storage section (Step S1), and changes a light source driving value to obtain the measured value P1 by the light quantity measuring sensor 3 (Step S2).

The control section 7 compares the desired value P0 and the measured value P1 (Step S3). When the measured value P1 exceeds the desired value P0, the control section 7 determines the light source driving value not to be less than the desired value P0 (Step S4). After that, the printing operation is performed (Step S6).

In Step 3, when the measured value P1 does not exceed the desired value P0, the control section performs an error handling S4. In the error handling S4, the display section 5 informs to a user the measured result. For example, the voice box makes a warning sound for lack of the light quantity, and the measured value is displayed on the image display device. At the same instant, it is preferable to display the notice that light quantity is lacking. Therefore, the measured result can be notified to the user.

In the error handling S4, the recoding operation by the ink jet heads 1 is banned. That is, the start of the

recoding operation by the ink jet heads 1 is banned. If the measuring is carried out during the recording operation, the recording operation is stopped and it is informed to a user by the display section 5. Therefore, the output of the recording medium on which uncured ink still exists can be prevented, so that the reliability of the ink jet recording apparatus is improved.

[0025]

The measured result may be informed to the user by the display section 5 without banning the recording operation by the ink jet heads 1 to perform the recording operation. In this case, since a user can know that the ink jet recording apparatus is operated with irradiation dose which is less than the ink curing energy, a user can take a necessary process such as radiating light by other light sources.

[0026]

The embodiment is an example in which four ink jet heads 1 are provided and one light source device 2 is disposed outside the area in which the four ink jet heads 1 are mounted.

When a plurality of light sources provided on the light source device 2 are provided to be disposed on one position seen from the main scanning direction A but on different positions seen from the carrying direction H of the recording medium, different light sources are moved to

the measuring region of the light quantity measuring sensor 3 in order by the light source scanning section which doubles as the recording head scanning section of the ink jet heads 1 to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring sensor 3. Therefore, a light quantity of every light source is measured. Accordingly, since the different light sources are measured by the same light quantity measuring sensor 3, the number of the light quantity measuring sensor 3 can be less than that of the light sources, and the apparatus can be simplified and miniaturized.

[0027]

According to the embodiment, since the light quantity of each light source can be measured, it is possible to pre-detect whether light quantity which is required to cure the ink is applied to the ink on the recording medium. Since the light quantity of each light source can be accurately controlled, the reliability of the ink jet recording apparatus is improved and the ink with high curing sensitivity which is cured by a relatively low-power light source such as the cationic polymerization ink can be put into practical use. Accordingly, since a light source with high-power is not required, the light source device 2 can be small. Therefore, the ink jet recording apparatus can be small and the cost for production can be reduced.

In addition, since the light source 2 and the ink jet heads 1 are mounted on the same carriage, both of them are uniformly incorporated in a saved space. Thus, the ink jet recording apparatus can be miniaturized.

[0028]

[Second Embodiment]

The second embodiment will be explained referring to FIG. 3. FIG. 3 is a sectional view showing the ink jet recording apparatus of the second embodiment in the present invention.

[0029]

As shown in FIG. 3, the ink jet recording apparatus in the embodiment comprises the sections (1(1a-1d), 2(2a-2e), 3, 4, 5, 6) which are similar to those in the first embodiment. The same sections are denoted by the same reference numerals.

However, the ink jet recording apparatus in the embodiment comprises five light source devices 2a-2e and each of the four ink jet heads 1a-1d is disposed between the light source devices 2a-2e, respectively, which is different from the first embodiment. When the carriage which mounts the ink jet heads 1a-1d and the light source devices 2a-2e moves in a left direction of the main scanning direction A on the drawing, the light source device 2a irradiates the ink jetted by the ink jet head 1a on the recording medium with ultraviolet rays (UV-rays),

the light source device 2b irradiates the ink jetted by the ink jet head 1b on the recording medium with UV-rays, the light source device 2c irradiates the ink jetted by the ink jet head 1c on the recording medium with UV-rays, and the light source device 2d irradiates the ink jetted by the ink jet head 1d on the recording medium with UV-rays. This configuration is effective for irradiating the ink jetted on the recording medium with UV-rays immediately.

[0030]

On the contrary, when the carriage moves in a right direction of the main scanning direction A on the drawing, the light source device 2b irradiates the ink jetted by the ink jet head 1a on the recording medium with UV-rays, the light source device 2c irradiates the ink jetted by the ink jet head 1b on the recording medium with UV-rays, the light source device 2d irradiates the ink jetted by the ink jet head 1c on the recording medium with UV-rays, and the light source device 2e irradiates the ink jetted by the ink jet head 1d on the recording medium with UV-rays.

As is described above, in the embodiment, the ink jet recording apparatus performs recording when the carriage is moved in either of the main scanning direction A. When the ink jet recording apparatus performs recording only when the carriage is moved in one of the main scanning direction A, one of the light source devices 2a, 2e at both ends is not needed.

[0031]

An operation of the light source control in the embodiment will be explained.

Before or during the recording operation by ink jet heads 1a-1d, although any order is acceptable, for example, the light source device 2a is moved to the measuring region D and disposes the light source device 2a at a position where the light quantity measuring sensor 3 can measure a light quantity of each light source provided on the light source device 2a. The light source devices 2a-2e and the ink jet heads 1a-1d are mounted on the same carriage same as the first embodiment, so that the above described operation is performed by moving the carriage.

The light quantity measuring sensor 3 measures the light quantity of each light sources provided on the light source device 2a.

[0032]

Next, the light source device 2b is moved to the measuring region D and is disposed at a position where the light quantity measuring sensor 3 can measure a light quantity of each light source provided on the light source device 2b. The light quantity measuring sensor 3 measures the light quantity of each light source provided on the light source device 2b.

[0033]

In the same manner as described above, the light

source device 2c-2e are moved to the measuring region D in order and are disposed at a position where the light quantity measuring sensor 3 can measure a light quantity of each light source provided in the light source device 2c-2e. The light quantity measuring sensor 3 measures the light quantity of each light source provided in the light source device 2c-2e in order.

[0034]

The control section 4 controls the light quantity of each light source provided on the light source device 2a-2e according to the measured value of each light source provided on the light source device 2a-2e, measured by the light quantity measuring sensor.

Other operations will be performed in the same manner as the first embodiment.

[0035]

As described above, in the second embodiment, even when the plurality of light sources are provided at different positions seen from the main scanning direction A, different light sources are moved to the measuring region D of the light quantity measuring sensor 3 in order by the light source scanning section which is configured by mounting the light source device 2a-2e on the carriage which moves the ink jet heads 1. Thus, the light quantity measuring sensor 3 can measure the light quantity of each of the plurality of light sources.

Accordingly, since the different light sources are measured by the same the light quantity measuring sensor 3, the number of the light quantity measuring sensor 3 can be less than that of the light sources, and the apparatus can be simplified and miniaturized.

[0036]

[Third Embodiment]

The third embodiment will be explained referring to FIG. 4. FIG. 4 is a bottom view from a lower surface side of the platen showing the ink jet recording apparatus of the third embodiment in the present invention.

[0037]

This embodiment relates to the invention which can be added to the above described first or second embodiment. FIG. 4 is described in case of adding this embodiment to the second embodiment.

In the above described first or second embodiment, it may be effective to arrange a plurality of dot light sources 11 whose irradiation area is dot shape in line in a direction perpendicular to the main scanning direction A, that is, the carrying direction H of the recording medium, which is the third embodiment. This embodiment is for responding to the case in which a plurality of jet openings 10 are arranged in line in the carrying direction of the recording medium. That is, when the plurality of jet openings 10 are arranged in line in the carrying direction

of the recording medium, one light source cannot irradiate all the ink dots with UV-rays. Therefore, in the embodiment, the plurality of dot light sources 11 are arranged in line in the carrying direction of the recording medium which is same as a direction of the arrow E in FIG. 4.

[0038]

However, as explained in the above described first or second embodiment, the light source scanning section can move only in the main scanning direction A. Since the plurality of light sources are provided at different positions seen from the direction E, a light quantity of every light source cannot be measured individually by only one light source. If a plurality of light quantity measuring sensors 3 are arranged in line in the direction E for measuring the light quantity of every light source, the number of the light quantity measuring sensors 3 increases.

Therefore, in the embodiment, the light quantity measuring sensor 3 is reciprocally moved in the direction E.

That is, a scanning section is provided, which moves the light quantity measuring sensor 3 in the carrying direction E of the recording medium so as to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring sensor 3. The scanning section can be configured by the well known moving mechanism, driving source and control section.

[0039]

An operation of the light source control in the embodiment will be explained. A sectional view is same as FIG. 3.

Before or during the recording operation by ink jet heads 1a-1d, although any order is acceptable, for example, the light source device 2a is moved to the measuring region D and disposes the light source device 2a at a position where the light quantity measuring sensor 3 can measure a light quantity of each light source provided on the light source device 2a. The light source devices 2a-2e and the ink jet heads 1a-1d are mounted on the same carriage same as the first embodiment, so that the above described operation is performed by moving the carriage.

The light quantity of each of the plurality of light sources 11 provided on the light source device 2a and arranged in line in the direction E is measured in order by the light quantity measuring sensor 3 while moving the light quantity measuring sensor 3 in the direction E.

[0040]

Next, the light source device 2b is moved to the measuring region D and is disposed at a position where the light quantity measuring sensor 3 can measure a light quantity of each light source provided on the light source device 2b. The light quantity of each of the plurality of light sources 11 provided on the light source device 2b and

arranged in line in the direction E is measured in order by the light quantity measuring sensor 3 while moving the light quantity measuring sensor 3 in the direction E.

[0041]

In the same manner as described above, the light source devices 2c-2e are moved to the measuring region D in order and are disposed at a position where the light quantity measuring sensor 3 can measure a light quantity of each light source provided on the light source devices 2c-2e. The light quantity of each of the plurality of light sources 11 provided on the light source devices 2c-2e and arranged in line in the direction E is measured in order by the light quantity measuring sensor 3 while moving the light quantity measuring sensor 3 in the direction E.

[0042]

The control section 4 controls the light quantity of each light source 11 provided on the light source device 2c-2e according to the measured values of each light source 11. Other operations will be performed in the same manner as the first embodiment.

[0043]

Accordingly, since the light sources at different positions are measured by the same light quantity measuring sensor 3, only one light quantity measuring sensor 3 can be used. Thus, the apparatus can be simplified and miniaturized.

[0044]

[Fourth Embodiment]

The fourth embodiment will be explained referring to FIG. 5. FIG. 5 is a bottom view from a lower surface side of the platen showing an ink jet recording apparatus of the fourth embodiment in the present invention.

[0045]

As shown in FIG. 5, the embodiment is for a line head type. In the line head type, the ink jet heads 1 and the light source devices 2 are fixed.

In the line head type, the jet openings 10 provided on the ink jet heads 1 form a line in a direction perpendicular to a carrying direction F of the recording medium. In the embodiment, a plurality of light sources 11 are provided so as to form a line in a direction G which is in parallel with the line of the jet openings 10 for the same purpose as in the third embodiment. For the purpose of simplifying the light quantity measuring sensor 3 as with the third embodiment, in the embodiment, a scanning section which moves the light quantity measuring devices 3 in the direction G to measure a light quantity of each of the plurality of light sources in order by the light quantity measuring sensors 3 is provided. The scanning section can be configured by the well known moving mechanism, driving source and control section.

[0046]

As shown in FIG. 5, when a plurality of lines of the light sources 11 are provided in the direction G because the plurality of light source devices 2 are provided, the light quantity measuring sensors 3 are provided corresponding to each line, respectively, to perform the following control operations at the same time. Each light quantity measuring sensor 3 is disposed at a position where a light quantity of each light source of a line corresponding thereto in the carrying direction F of the recording medium can be measured.

The platen 6 is disposed between the light quantity measuring sensors 3 and the light sources 11. For enabling the light quantity measurement in the following control operations, at least a portion of the platen 6 just below the light sources 11 comprises through holes for passing the light therethrough or a transparent portion. In the line heads, since the light sources 11 are fixed, the light quantity measurement can be performed by partially providing holes for passing the light therethrough or a transparent portion.

[0047]

An operation of the light source control in the embodiment will be explained.

Before or during the recording operation by ink jet heads 1, scanning is carried out so as to sequentially measure a light quantity of each light source 11 disposed

in line on each of the light source devices 2 in the direction G while moving each of the light quantity measuring sensors 3 in the direction G.

[0048]

The control section 4 controls a light quantity of each light source 11 according to the measured value of each light source 11, measured by the light quantity measuring sensor 3.

Other operations will be performed in the same manner as the first embodiment.

[0049]

According to the embodiment, in the ink jet recording apparatus of line head type, since different light sources are measured by the same light quantity measuring sensor 3, the number of the light quantity measuring sensor 3 can be reduced. Thus, the ink jet recording apparatus can be simplified and miniaturized.

[0050]

In the first to third embodiments, the measuring region may be disposed in the recording region B. In this case and in the fourth embodiment, a light quantity is measured when the recording medium does not exist between the light sources and the light quantity measuring sensor 3. That is, the light quantity measurement of each light source can be performed from the time a back end of a recording medium passed between the light source and the

light quantity measuring sensor 3 to the time a front end of a next recording medium is carried between the light sources and the light quantity measuring sensor 3.

[0051]

In the first to third embodiments, as the time interval to perform the light quantity measurement of each light source, the light quantity measurement can be performed every one scanning of image formation as a minimum unit according to the above described embodiments. When the light quantity measurement is performed frequently such as every one scanning of image formation, a change which occurs in a relatively short period of time such as a decrease of irradiation amount by ink mist can immediately be detected.

When a decrease of printing speed is considered or when a problem is a change of light quantity in a relatively long period of time (for example, decrease of output of a light source by the degradation in the electric system including the light quantity measuring sensor 3), the light quantity measurement is carried out by utilizing the starting time or the standby time of waiting the instructions such as a width of paper or a printing job to be input. In addition, the light quantity measurement may be carried out in consideration of the preset elapsed time.

[0052]

Each technical term that is adaptable to the embodiments in the invention will be explained.

<Jetting Amount>

Ink jetting amount per dot is 2pl-20pl (pico liter), and preferably 4pl-10pl. When the ink jetting amount per dot exceeds 20pl, it is difficult to perform a high definition printing, and when the ink jetting amount per dot is less than 2pl, it diminishes in thickness of a formed image.

[0053]

<Dot Diameter>

The dot diameter formed on the recording medium is 50 μm-200μm, preferably 50μm-150μm, and more preferably 55 μm-100μm. When the dot diameter is less than 50μm, it diminishes in thickness of a formed image, and when the dot diameter exceeds 200μm, it is difficult to perform a high definition printing.

[0054]

<No Water And Organic Solvent>

Preferably, the ink which is used does not substantially contain water and organic solvent, that is, the content of water and organic solvent is less than 1 wt%.

[0055]

<Ink Jet Type>

As an actuating force for ink jetting of the ink jet printer, it is preferable to utilize a piezoelectric

actuation of a piezoelectric element, which is capable of wide application to the ink and in which the high-speed jetting is possible. Specifically, for example, as described in Japanese Patent Publication No. Hei 4-48622, the ink jet printer is the ink jet head type in which an electrode layer is formed inside a fine groove formed on a piezoelectric base substance and further being covered with an insulating layer for forming an ink path.

[0056]

<Irradiated Radiation Source>

Various radiation sources which radiate UV-rays, electron beams, X-rays, visible rays or infrared rays can be utilized. However, considering the curing property and the cost of radiation source, the radiation source which radiates UV-rays is preferable. As the UV radiation source, a mercury lamp, metal halide lamp, excimer lamp, UV laser or LED can be used.

A basic irradiation method is disclosed in Japanese Application Patent Laid-Open Publication No. Sho 60-132767. According to the publication, a light source is provided on both sides of a head unit, and a head and a light source are scanned by a shuttle type. The irradiation is performed in a certain length of time after ink is jetted. Further, another light source which is not driven is used to complete ink curing. There is disclosed in WO9954415 irradiation methods such as a method using optical fiber

and a method in which a collimated light source is directed to a mirror surface provided on a side surface of a head unit to irradiate a recorded portion with UV-rays. In the embodiments in the present invention, any of these irradiation methods is applicable.

Specifically, a strip-shaped metal halide lamp bulb or ultraviolet lamp bulb is preferable. It is possible to construct a radiation source at lower cost by practically fixing a radiation source on an ink jet printer and eliminating moving parts.

It is preferable that irradiation is performed at every image formation of each color. That is, it is a preferred embodiment that two radiation sources are provided in any exposure method to be employed, and ink curing is completed by the second radiation source. This contributes to achieving high wetting property of the jetted ink of the second color, adhesiveness between inks, and constructing a radiation source at lower cost.

It is preferable to vary the exposure wavelength or exposure illumination of the first radiation source from that of the second radiation source. The first irradiation energy is set smaller than the second irradiation energy, that is, the first irradiation energy is set to 1 to 20% of total irradiation energy, or preferably to 1 to 10%, or more preferably to 1 to 5%. Irradiation at different lighting intensity helps achieve favorable molecular weight

distribution after being cured. That is, if irradiation at high lighting intensity is performed at a time, high polymerization ratio is attained but the molecular weight of the polymerized composition is lower and accordingly necessary strength cannot be achieved.

By using longer wavelength in the first irradiation than in the second irradiation, the surface layer of the jetted ink can be cured in the first irradiation and hence blurredness can be suppressed, and the ink layers close to the recording medium to which irradiated radiation hardly reaches can be cured in the second irradiation and hence adhesiveness can be improved. The wavelength of the second irradiation is preferred to be longer in order to accelerate curing of the inside of ink.

[0057]

<Timing Of Irradiation>

The above-mentioned ink is employed and the ink is heated to a constant temperature and also that the elapse time from the jetting of the ink to the irradiation is set to 0.01 to 0.5 second, or preferably to 0.01 to 0.3 second, or more preferably to 0.01 to 0.15 second. By controlling the elapse time from the jetting of the ink to the irradiation extremely shorter, the jetted ink can be prevented from being blurred before it is cured. Beside, even in case a porous recording medium is used, the ink can be exposed to the irradiation light before the ink

penetrates deep into pores to which the light cannot reach, and hence residual unreacted monomer can be minimized and smell can be reduced. This means that use of the ink with high viscosity produces a remarkable synergy effect. Specially, a remarkable effect can be obtained by using ink with viscosity of 35 to 500 mPa.s at 25 degree C. With the recording method as above, sizes of the dots jetted even on various types of recording media of different surface wetting property can be kept constant and hence the image quality can be improved. In order to attain an excellent color image, it is preferable to superpose colors in order of the brightness, starting from the lowest. If ink with low brightness is superposed on the top, the irradiation light hardly reaches the lower layers of the ink, and hence curing sensitivity is apt to deteriorate, residual monomer to increase, smell to be caused, and adhesiveness to decrease. Irradiation can be performed in one time after all colors of ink are jetted, however, individual irradiation on each color is preferable in view of accelerated curing.

On a unit equipped with heads of different colors, it is preferable to construct the unit so that irradiation light is permeable among the colors. To be concrete, a portion between the heads is made of irradiation permeable member or no member is disposed between the heads. A simple construction as above is preferable because

irradiation can be performed for each color immediately after the ink is jetted and, in particular, the next color to follow can be prevented from blurredness and also, in two-directional printing, difference between the blurredness in one direction and in the other can be prevented (preventing difference between the colors in one direction and in the other).

[0058]

<Ink Heating And Head Temperature Control>

It is preferable to heat the above ink to 30 to 150 degree C, or more preferably to 40 to 100 degree C, so as to jet the ink with low viscosity in view of stable jetting of the ink. If the temperature is below 40 degree C or above 150 degree C, the ink cannot be jetted smoothly. Because light curable ink has generally higher viscosity than water ink, the range of viscosity variation caused by temperature variation is greater. Because the viscosity variation gives a direct and remarkable effect on a droplet size and droplet jetting velocity, resulting in poor image quality, the ink temperature needs to be kept as stable as possible. The control range over the ink temperature is set to +-5 degree C, or preferably to +-2 degree C, or more preferably to +-1 degree C. The recording device is equipped with a means for stabilizing the ink temperature, and the portions to be kept at a constant temperature include all tubes and parts from the ink tank (or

intermediate tank if provided) to the jetting surface of the nozzles.

For the temperature control, it is preferable to provide a plurality of temperature sensors on various points on the tubing and heat control is employed in accordance with the ink flow rate and ambient temperature. It is preferable that the head unit to be heated is thermally isolated or insulated so as not to be affected by the temperature of the apparatus itself and of the ambient. To reduce the start-up time needed for heating the apparatus and also to reduce the loss of heat energy, it is preferable to thermally insulate the heating unit from other portions and also to reduce the overall thermal capacity of the unit.

[0059]

<Recording Medium With No Ink Absorptivity>

In the embodiments of the present invention, a recording medium with no ink absorptivity or low ink absorptivity (or ink nonabsorbable recording medium) can be used. The above recording medium means a recording medium or a recording medium having a surface layer (image forming layer) made of a material with no ink absorptivity or low ink absorptivity (or ink nonabsorbable material). The material with no ink absorptivity or low ink absorptivity (or ink nonabsorbable material) means, for example, resin or metal of various kinds.

[0060]

<Viscosity>

The ink in the present invention is a liquid with viscosity of 10 to 500 mPa.s at 30 degree C, and preferably 40 to 500 mpa.s. If the viscosity is less than 10 mpa.s, blurredness becomes remarkable and, if it exceeds 500 mPa.s, smoothness of print is lost. The ink is preferably a liquid with viscosity of 3 to 30 mPa.s at 60 degree C, and more preferably 3 to 20 mPa.s. If the viscosity is less than 3 mPa.s, high speed jetting results in failure and, if it exceeds 30 mPa.s, jetting property deteriorates.

[0061]

[Effect of the Invention]

According to the present invention, a light quantity of a light source can be measured, so that it is possible to pre-detect whether the light quantity which is needed for ink curing is given to the ink on the recording medium. Thus, a light quantity of a light source can be controlled with high accuracy. Accordingly, reliability of the ink jet recording apparatus can be improved.

Since a light quantity of a light source can be controlled with high accuracy, the ink with high curing sensitivity which is cured by a relatively low-power light source such as cationic polymerization ink can be put into practical use. Accordingly, since a light source with high-power is not required, the light source device can be

small. Therefore, the ink jet recording apparatus can be small and the cost for production can be reduced.

[BREIF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

This is a sectional view showing an ink jet recording apparatus of the first embodiment in the present invention. (a) and (b) show the time of an operation which is from each other.

[FIG. 2]

This is a flow chart showing one example of process by a control section.

[FIG. 3]

This is a sectional view showing an ink jet recording apparatus of the second embodiment in the present invention.

[FIG. 4]

This is a bottom view from a lower surface side of a platen showing an ink jet recording apparatus of the third embodiment in the present invention.

[FIG. 5]

This is a bottom view from a lower surface side of a platen showing an ink jet recording apparatus of the fourth embodiment in the present invention.

[Explanation of the Symbols]

1: ink jet head

2: light source device

3: light quantity measuring sensor

4: control section

5: display section

6: platen

10: jet openings

11: light source

[DOCUMENT] Abstract

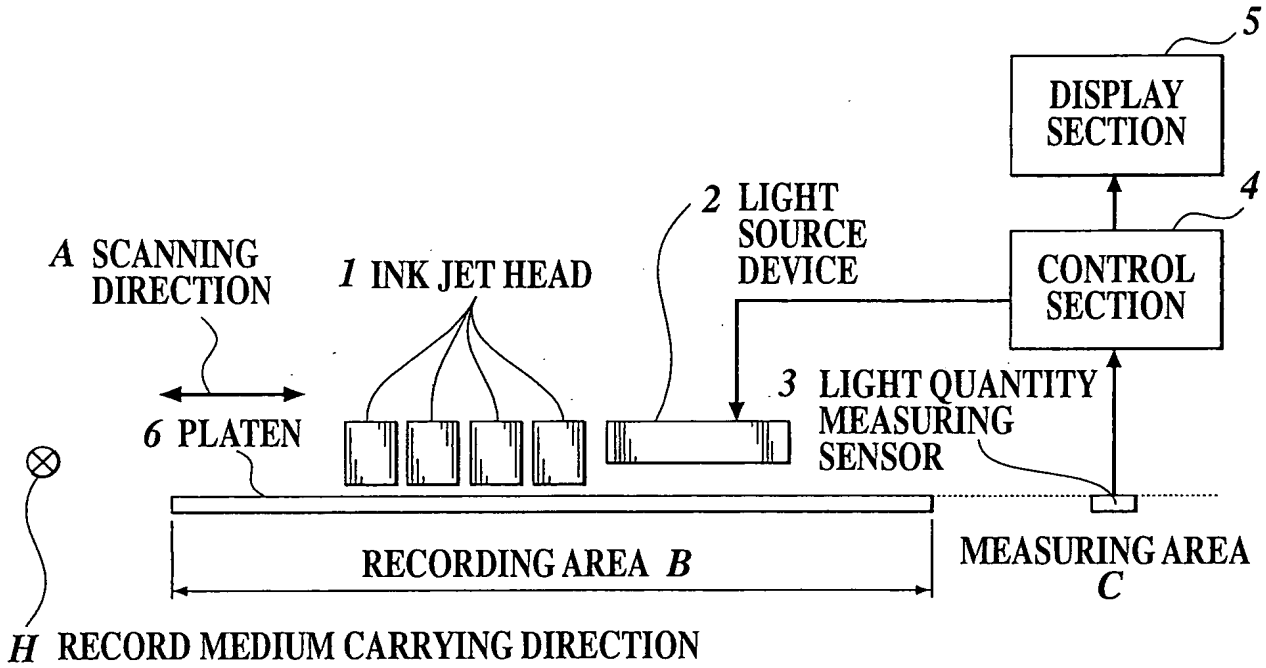
[ABSTRACT]

[OBJECT] An object is to improve reliability of an ink jet recording apparatus in which photo curable ink is used, by preventing printing failure by curing failure. This enables cationic polymerization ink with high curing sensitivity which is cured by a relatively low-power light source to put into practical use, thereby miniaturizing the apparatus and reducing the cost for production.

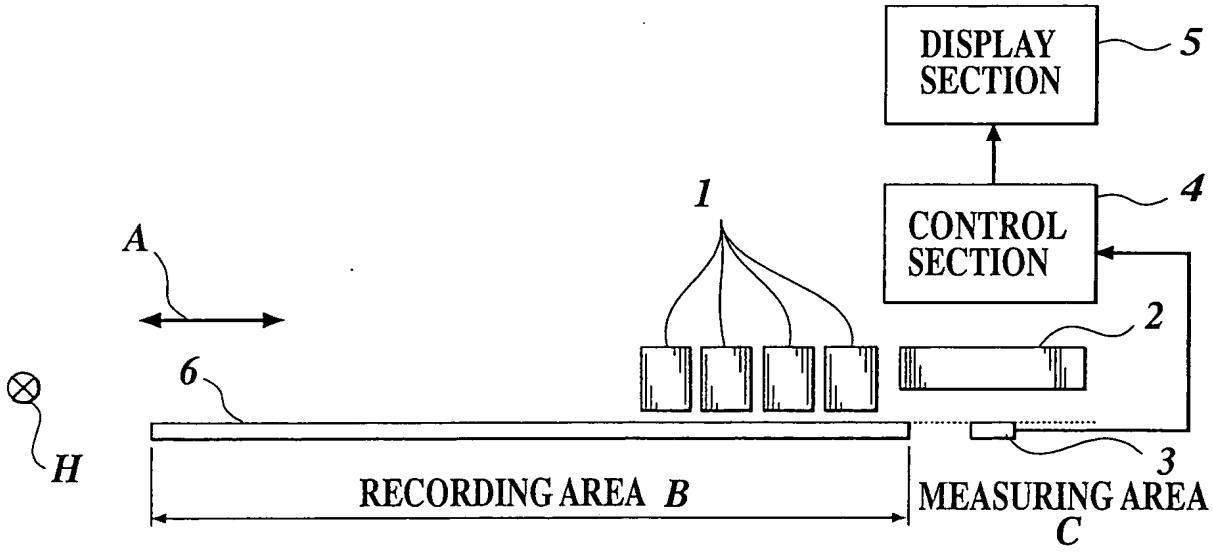
[MEANS FOR SOLUTION] The present invention comprises, a light source 2 for emitting light to cure an ink jetted from the ink jet head 1 and adhered to a recording medium, a light quantity measuring sensor 3 for measuring a light quantity of the light source 2, and a control section 4 for controlling the light quantity of the light source 2 according to a measured value by the light quantity measuring sensor 3. In addition, a light source scanning section and scanning section for the light quantity measuring sensor 3 is provided to enable light quantity measurement of a plurality of light sources with a small number of light quantity measuring sensor 3. An display section 5 is provided to inform a user in case the light quantity is less than the desired value, and recording operation is banned.

[SELECTED FIGURE] FIG. 1

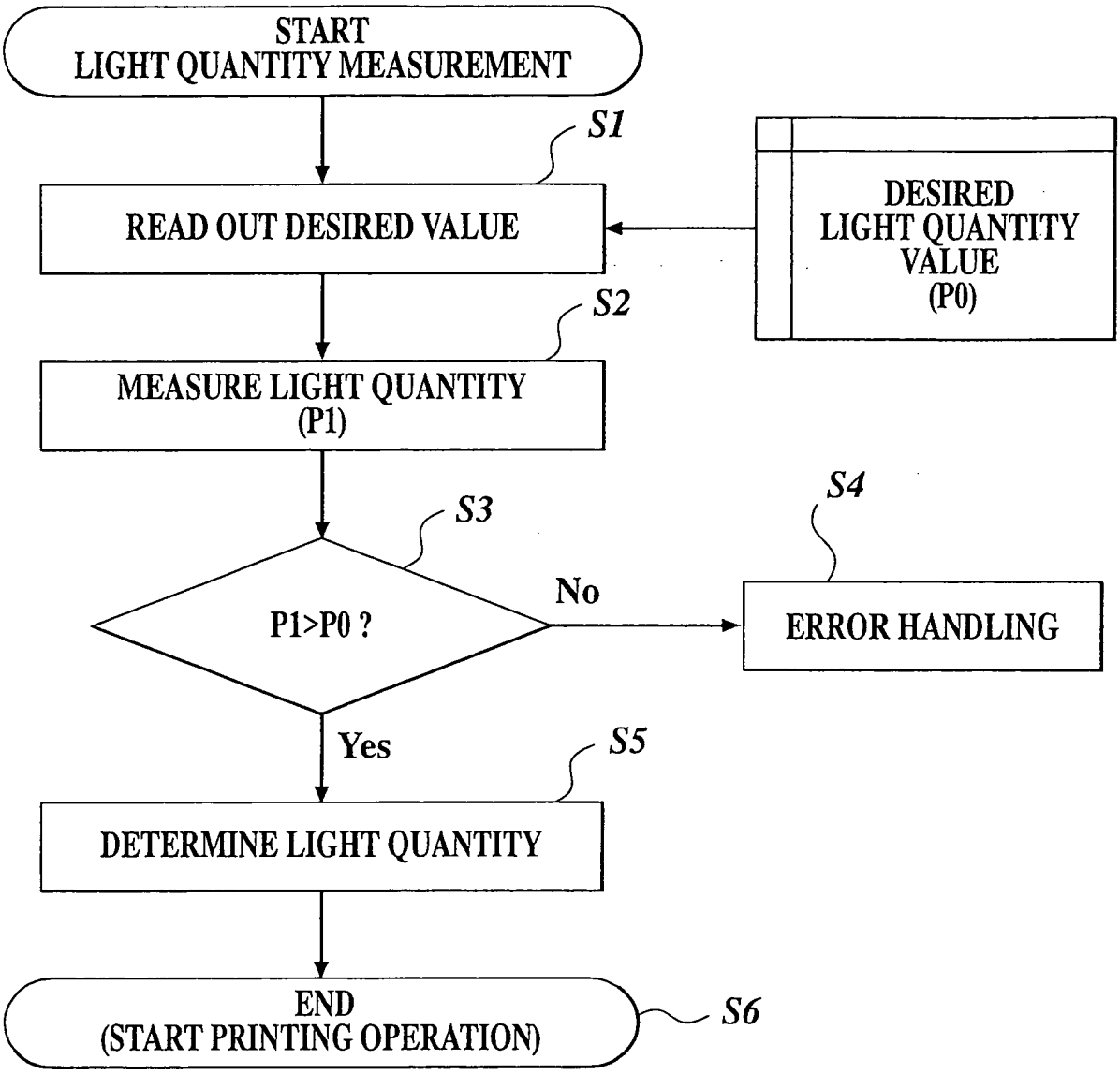
[FIG. 1(a)]


5
DISPLAY SECTION
4
CONTROL SECTION
2 LIGHT SOURCE DEVICE
A SCANNING DIRECTION
1 INK JET HEAD
3 LIGHT QUANTITY MEASURING SENSOR
6 PLATEN
RECORDING AREA B
MEASURING AREA C
H RECORD MEDIUM CARRYING DIRECTION

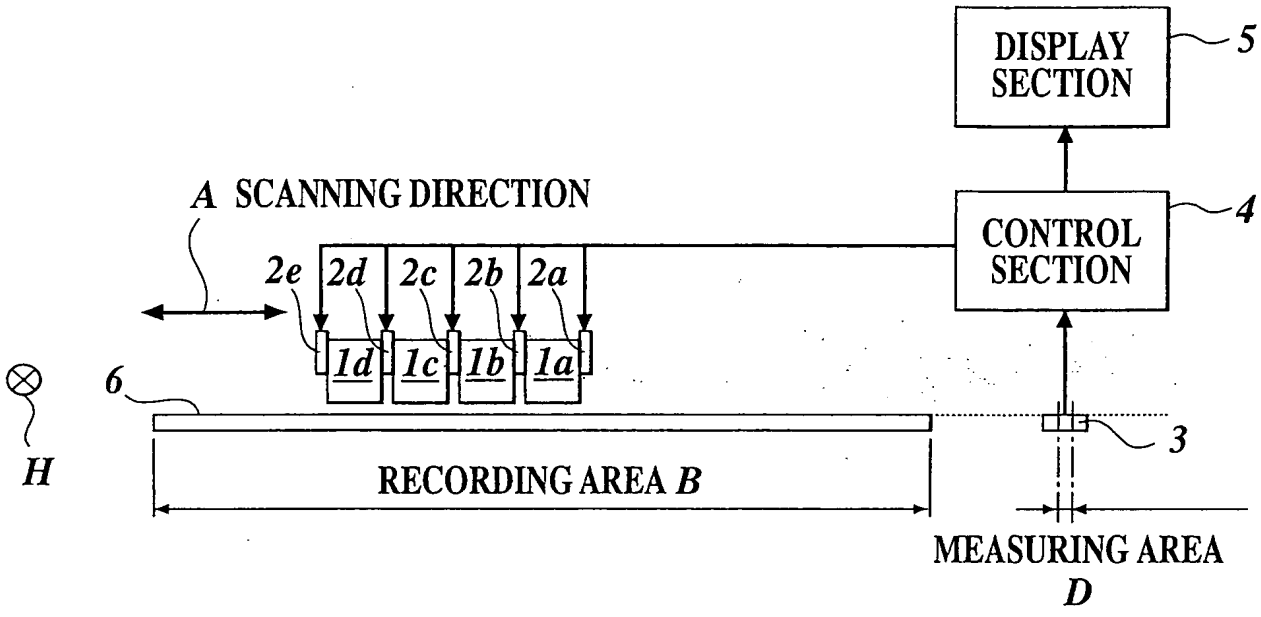
[FIG. 1(b)]


DISPLAY SECTION
5
1
4
CONTROL SECTION
A
2
6
3
H
RECORDING AREA B
MEASURING AREA C

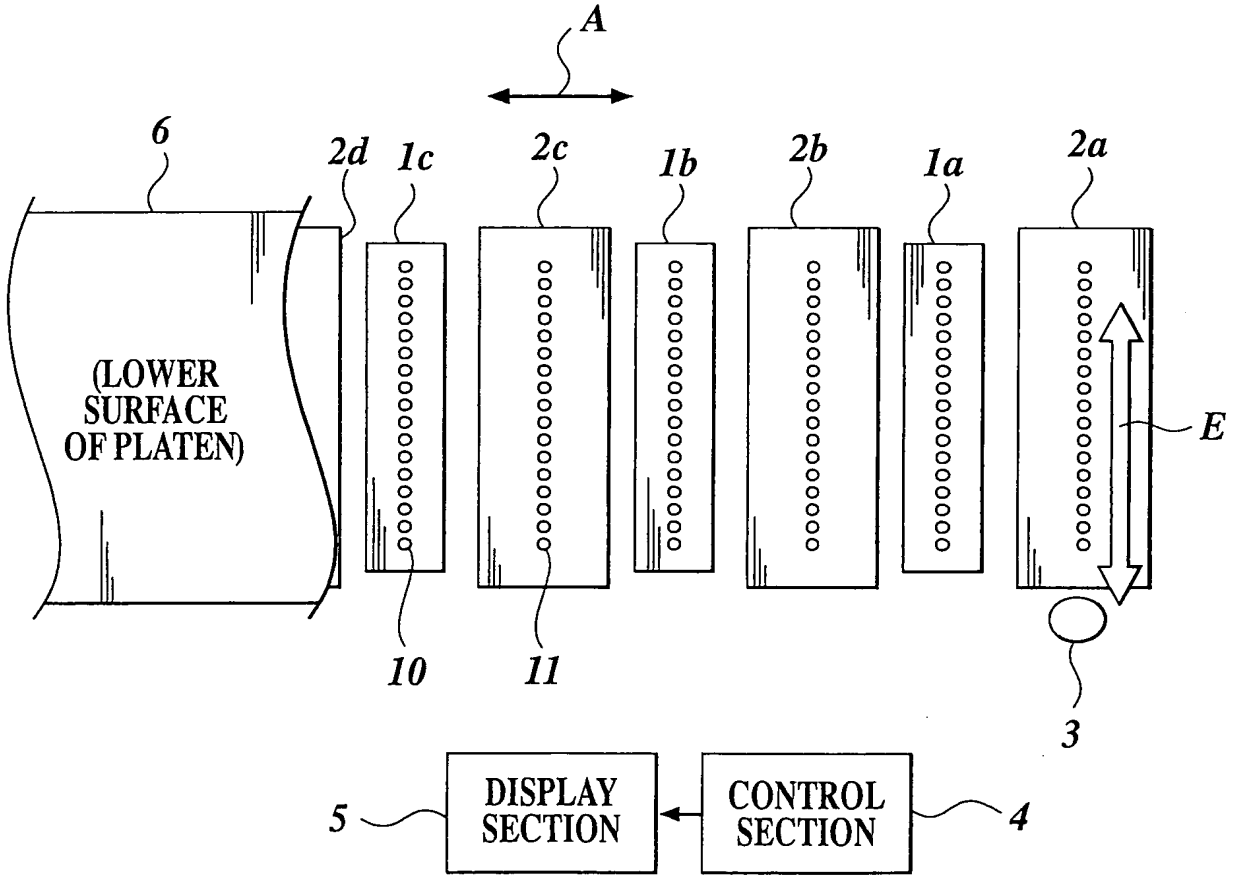
[FIG. 2]


START
LIGHT QUANTITY MEASUREMENT
S1
READ OUT DESIRED VALUE
DESIRED
LIGHT QUANTITY
VALUE
(P0)
S2
MEASURE LIGHT QUANTITY
(P1)
S3
P1>P0 ?
No
S4
ERROR HANDLING
Yes
S5
DETERMINE LIGHT QUANTITY
END
(START PRINTING OPERATION)
S6

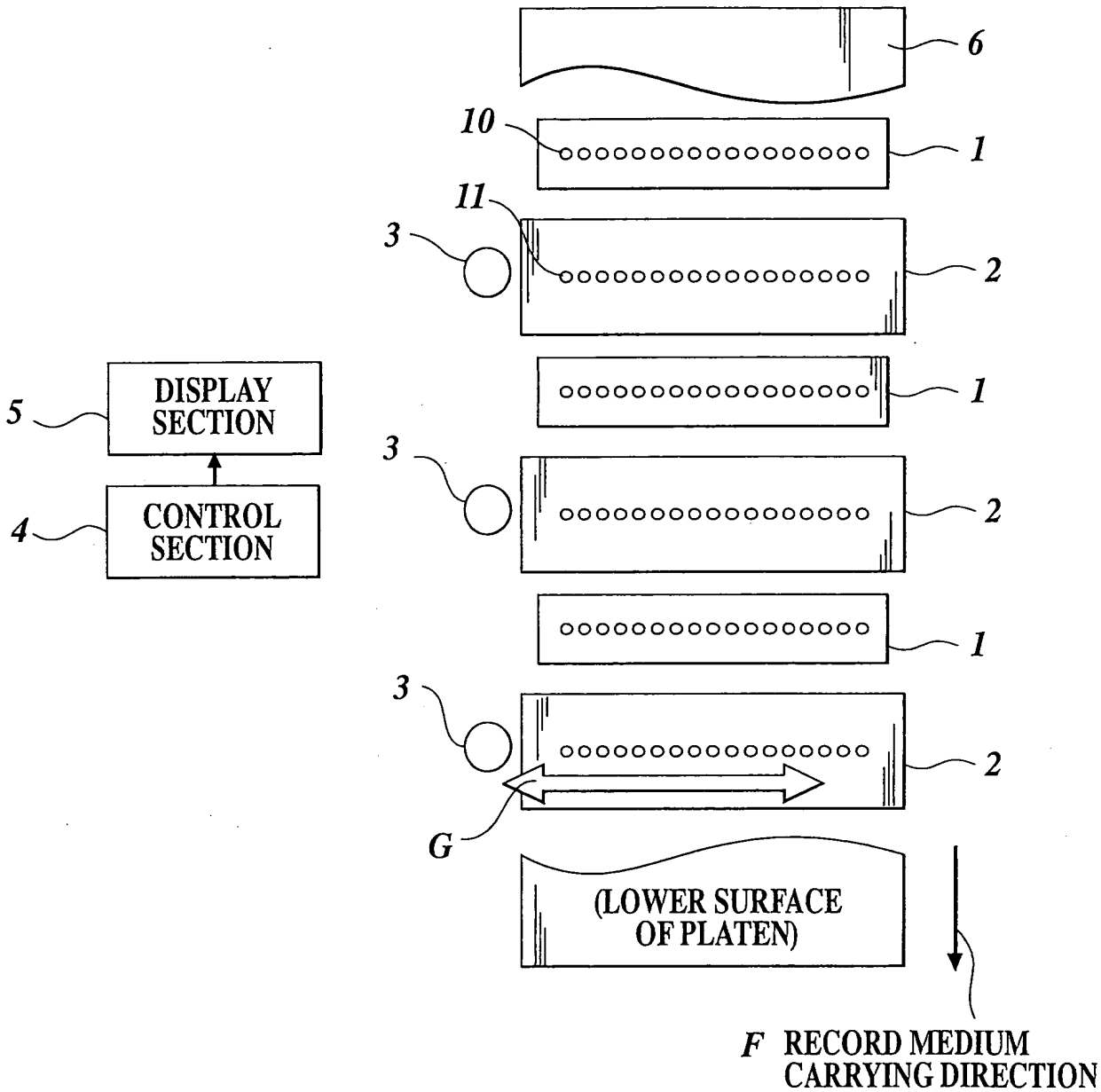
[FIG. 3]


DISPLAY SECTION
5
A SCANNING DIRECTION
CONTROL SECTION
4
2e
2d
2c
2b
2a
1d
1c
1b
1a
6
H
3
RECORDING AREA B
MEASURING AREA D

[FIG. 4]


A
6
2d
1c
2c
1b
2b
1a
2a
(LOWER SURFACE OF PLATEN)
E
10
11
3
5
DISPLAY SECTION
CONTROL SECTION
4

[FIG. 5]


6
10
1
11
3
2
1
5
DISPLAY SECTION
3
2
4
CONTROL SECTION
1
3
2
G
(LOWER SURFACE OF PLATEN)
F RECORD MEDIUM CARRYING DIRECTION